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Ecological Survey of the Vegetation of White Mountain Natural Area, Inyo National Forest California

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Abstract

White Mountain Natural Area is located on the eastern crest of the White Mountains, California. The Natural Area is administered by the U.S.D.A., Forest Service, Inyo National Forest. The area represents a pristine stand of Western Bristlecone Pine (Pinus longaeva) (SAF-209). This report provides a description of the vegetation of the Natural Area.

INTRODUCTION

Location. White Mountain Natural Area is located on the eastern crest of the southern White Mountains, California, in Mono County (37°31'N, 118°11'w) (See Maps 1 & 2). The area includes portions of Secs. 1, 12, 13, 14 of T5S,R34E, and Secs 6, 7, 8, 18, of T5S,R35E, M.D.M. White Mountain Natural Area comprises 932 ha (vertical projection) ranging in elevation from 2877 to 3485 m.

Area Boundaries. White Mountain Natural Area is located between the South Fork Cottonwood Creek above the junction with Poison Creek and below roads 4S01 and the Patriarch Grove Access road (See Map 1). The area as delineated generally provides boundaries which are conducive to manage as a natural preserve, with one possible exception: the Patriarch Tree visitation site is located immediately adjacent to the Natural Area on a small flat between interfluves of the headwaters of Cottonwood Creek which drain the area. An access road with accompanying minor visitor facilities thus directly abuts the boundary. A short trail with rest-benches enters the Natural Area for several hundred meters. Also, a low voltage power line crosses one corner of the Natural Area at the southwest end near Campito Meadow. There is access to the lower end of the natural area via a four-wheel drive road to McCloud Camp via Crooked Creek. Direct impact on he Natural Area, as evidenced by man's artifacts (e.g., cans) seems very minimal over most of the area, excepting the area in the immediate vicinity of the Patriarch Tree; there, litter is

evident along the trail into the natural area and some snags have been cut for unknown purposes. Grazing stock (cattle) regularly enter the Natural Area, as evidenced by fresh scat observed in both 1977 and 1978. This trespass on the upper end of the Natural Area results from strays entering via Campito Meadow, where there are extensive meadows in sagebrush vegetation. Forage availability rapidly declines within the Natural Area, so the strays rarely linger in the upper reaches, and thus impact is relatively minimal. Trespass from the lower end along Cottonwood Creek is serious, and results in the overutilization of meadows located within and on the boundaries of the Natural Area.

About 2.5 miles north of White Mountain Natural Area is the 2030-ha White Mountain Scientific Area, which is jointly managed for research use by the University of California and Inyo National Forest. White Mountain Natural Area abuts the 11,584-ha Ancient Bristlecone Pine Forest, which is administered by the Inyo National Forest to provide protection to the unique ecosystems present therein. Together, these administrative units provide an extensive, comprehensive natural area system which adequately represents subalpine and alpine habitats in the White Mountains.

Physiography. White Mountain Natural Area is located at the upper reaches of Cottonwood Creek, on the eastern flank of the White Mt. crest on Sheep Mt. (3809 m). Slopes in the Natural Area are steep, averaging about 30°. The area is dissected by numerous ephemeral tributaries of Cottonwood Creek which carry water only during snowmelt. Drainage patterns on the northern half of the area trend east-west, and are cut 75-100 m deep into the slope. The drainageways in the southern half trend northwest-southeast and are cut equally deep. At the northern upper end of the Natural Area, lower-angle slopes occur on several broad interfluves, and several small rounded summits are found. Colluvial deposits are common at the base of the steeper slopes, most of which is avalanche deposited.

Geology and Soils. Map 3 taken from Krauskopf (1971) shows the bedrock geology in the vicinity of the Natural Area. The site for the most part is underlain by calcareous rocks of the Reed Dolomite formation (Precambrian). Small outcrops of the calcareous Wyman formation are found at the lower end of the Natural Area. Extensive outcrops of granitic rocks (Jurassic quartz monzonite) occur to the northeast of the area boundaries. Most of the Natural Area apparently escaped active glaciation in the Pleistocene, although a small cirque glacier 1 km to the north in another tributary of Cottonwood Creek was active then. The upper reaches of the Natural Area exhibit a variety of periglacial processes, frost-riving and sorting being the most predominant forms. Patterned ground is evident on the small summits at the upper end of the Natural Area and is not active at present, indicating a Pleistocene origin. There is an extensive literature on the weathering characteristics of Reed Dolomite, derived from research in and about the Natural Area. This literature is summarized in LaMarche (1968) and Marchand (1974). Soils of the Natural Area are shallow (0.3-0.5 m) lithosols. Marchand (1974) gives the following data for soils derived from Reed dolomite: ph 8.0 $\pm$ 0.1; Cation Exchange capacity (%), K 1.6, Na 0.7, Ca 80.7, Mg 16.9. Marchand's paper discusses soil forming processes in detail.

Regional Climate. Figure 1 gives a water balance estimate (Major 1977) for the nearby Crooked Creek and Mt. Barcroft Lab recording stations (Pace 1973). During his dissertation studies, Marchand (1974) maintained several weather stations in the vicinity of White Mountain Natural Area. Only precipitation was measured at his Patriarch Grove site. His measurements of total precipitation at Patriarch are less by about 25% than those of nearby Crooked Creek. Marchand's records are from unshielded gauges, which are known to underestimate total snowfall, and the Crooked Creek guages are shielded. Thus the difference in total precipitation between the two sites is probably

attributable to catchment error. Monthly temperature and precipitation figures were used to construct the water balance given in Figure 1, and the Crooked Creek data were used.

Vegetation

Survey Methods

Reconaissance. Seventy stands of subalpine-alpine vegetation in the White Mountains have been sampled by the author using the releve method described by Mueller-Dombois and Ellenberg (1974). Stands of homogeneous vegetation are selected at localities representative of various positions along major environmental gradients. Cover for each species in a stand is estimated using the following scale:

R = one or a few individuals

\+ = less than 1% cover

1 = 1-5% cover

2 = 5-25% cover

3 = 25-50% cover

4 = 50% cover

5 = greater than 75% cover

The data collected in this manner is displayed in an analyzed form in Table 1.

Sampling. Six Pinus longaeva stands on the White Mt. Natural Area were selected for detailed analysis. All trees within a 15-m radius circle were measured for cross-sectional area of wood: the noncircular growth pattern of P. longaeva makes this measurement difficult to make with accuracy. A diameter tape was carefully laid around the outer circumference of each tree just above the buttswell, attached in place to the trunk where necessary to gauge the true circumference. The basal area (note: not at breast height!) was thus determined from the measurement of each trunk. Cover of each associated species in these stands was estimated as above.

Vegetation Units. There is a very extensive literature on the vegetation of the upper elevations of the southern White Mountains, and for Pinus longaeva stands in particular.

Interest in the ecology of P. longaeva vegetation began with Schulman's (1954) observation that P. longaeva individuals attain extreme longevity under adversity. Schulman and his colleagues from Arizona then published a succession of papers on the dendrochronology of P. longaeva (see Ferguson 1968, Fritz 1975 for references). Billings and Thompson (1957) provide a description of a single P. longaeva stand near Schulman Grove. Western populations of bristlecone pine are considerably different from stands east of the Colorado River (Zavarin et al. 1976, Critchfield 1977), which led Bailey (1970) to apply the name P. longaeva to the western populations. The older name, P. aristata, which is now applied only to eastern populations of bristlecone pine, is used in the older literature for the White Mt. trees.

Wright (1963), Marchand (1973) and Wright and Mooney (1965) provide descriptions of the major vegetation patterns in the subalpine zone of the southern White Mountains. Pinus longaeva is restricted to calcareous substrates in the southern White Mountains, contrasting sharply with Artemisia-dominated vegetation on adjacent sandstones and shales. This substrate-oriented distribution of P. longaeva does not hold true in the northern White Mountains, where stands of this species are common on granitic rocks. Other species also show strong substrate restrictions in the southern White Mountains (Marchand 1973, Mooney 1966). The timberline ecotone occurs at ca. 3400 $\pm$ 100 m in the southern White Mountains. Krummholz forms are absent in P. longaeva (Major and Taylor 1977), although individuals do change growth form along an altitudinal gradient (cf. Figure 2). The trees become more bulky with lower heights and smaller crown volumes as timberline is approached. Large, standing dead P. longaeva above the present timberline

represent a Xerothermic (ca. 5000 yr B.P.) extension of forest to 100 m above the present level (LaMarche 1973, LaMarche and Mooney 1967).

Alpine vegetation in the White Mountains has been described by Mooney et al. (1962), Mitchell et al. (1966) and Major and Taylor (1977). A previous vegetation reconnaissance report was prepared for the nearby White Mountain Scientific Area (Taylor 1976).

Table 1 presents a preliminary classification of Alpine-Subalpine vegetation for the southern White Mountains. The arrangement of the species/stand matrix shown was arrived at by application of a classification algorithym (Ceska and Roemer 1971, cf. Mueller-Dombois and Ellenberg 1974). The classification scheme shown in Table 1 is hierarchical: the vegetation is recognized to fall within several subdivisions termed orders, alliances and associations. A basic outline of the classification scheme follows: (* = present on White Mt. Natural Area):

Alpine Scree communities

Order: Polemonium viscosum

Alliance: Polemonium exemium-Hulsea algida

Polemonium chartaceum-Erigeron vagus association

Sedge Meadow Communities

Order: Antennaria alpina-Carex vernacula

Alliance: Antennaria alpina-Ivesia lycopodioides scandularis

Carex subnigricans association

Ivesia lycopodioides scandularis association

Alpine Steppe Communities

Order: Sitanion hystrix-Phlox covillei

Alliance: Carex eleocharis-Trifolium monoense

Trifolium monoense-Koeleria cristata association

Artemisia cf. arbuscula association

*Alliance: Phlox covillei-Eriogonum gracilipes

*Phlox covillei-Eriogonum gracilipes association

*Alliance: Poa fendleriana-Lomatium inyonese

*Artemisia cf. rothrockii association

*Pinus longaeva association

The three alpine-subalpine vegetation units denoted with * above occur on the White Mountain Natural Area. Additionally, four other kinds of vegetation are recognizable on the Natural Area, but these have not been sufficiently studied to include within a vegetation classification at this time. These are: subalpine meadows in Artemisia scrub (dominated by Carex douglasii, Agropyron trachycalum, Juncus balticus and Poa fendleriana); Pinus longaeva-Cercocarpus intricatus forests, Pinus flexilis-Cercocarpus ledifolius forests (cf. Brayton and Mooney 1966); and Populus tremuloides forests. Map 4 shows the distribution of these vegetation types on the White Mountain Natural Area.

Phlox covillei-Eriogonum gracilipes Association: This association is limited to alpine sites underlain by Reed dolomite. The vegetation is sparse, usually with less than 30% cover, and shows low biomass and productivity. Phlox covillei and Eriogonum gracilipes are diagnostic and dominant taxa for this vegetation, the latter species being endemic to this vegetation. Linum lewisii, Astragalus calycosus, A. kentrophyta danaus, and Hymenoxus cooperi are species common in this vegetation. In the Natural Area, this vegetation is restricted to the upper slopes just at timberline, as on the north slope of

hill 11436, or in snow accumulation sites, as along the Patriarch grove access road just after it leaves the main road. The extensive "dolomite barrens" north of Sheep Mt. (cf. Lloyd and Mitchell 1974) comprise this association. This vegetation type covers about 10% of the White Mountain Natural Area.

Artemisia cf. rothrockii Association: Low shrubs dominate this vegetation type, with Artemisia cf. rothrockii and Chrysothamnus viscidiflorus being common. Stipa pinetorum, Lupinus meionanthus, Agoseris glauca and Cryptantha jamesii are common associated species. This vegetation is limited to calcareous substrates at the upper elevations of the White Mountain Natural Area. Artemisia rothrockii dominates sites here where there are shallow depressions or small drainageways filled with colluvium, as along the upper reaches of the South Fork Cottonwood Creek. Standing biomass and productivity is moderately high in this vegetation. This association covers ca. 10% of the White Mountain Natural Area.

Species of Artemisia section Tridentateae are not easily distinguishable in the field (West et al. 1978). Previous workers in the White Mountains (e.g., Mooney et al. 1962, West and Mooney 1972, Marchand 1973) have recognized only A. arbuscula as being important in the subalpine-alpine vegetation of the White Mountains. Artemisia tridentata ssp. vaseyana and A. rothrockii are present and often abundant, however. Stands on dolomite sampled in this study were dominated by Artemisia shrubs with greatest morphological similarity to A. rothrockii, whereas shrubs from sandstone stands were most similar in morphology to the A. arbuscula type. Resolution of what could well be major taxonomic discrepancies in the placement of Artemisia in specific and subspecific taxa for previous vegetation surveys of the White Mountains will require application of the recent discrimination methods developed by Hanks et al. (1973) and Stevens and McArthur (1974). Artemisia section Tridentateae in the White Mountain Natural Area is provisionally assigned to A. rothrockii, based on morphological criteria.

Pinus longaeva association. Pinus longaeva forms an open subalpine woodland in the upper reaches of the Natural Area. Canopy cover in this vegetation is about 15-20% maximum. Pinus longaeva individuals in this vegetation are almost always multitrunked, with massive trunks and only partial live canopies. Most of the cross-sectional surface of P. longaeva trunks is dead wood, cambium being maintained over only a small proportion of the outer surface so as to compensate for slow growth rates (Wright 1963, Schulze et al. 1967). Pinus longaeva growth form becomes more massive at higher elevations as depicted in Figure 2.

Basal Area and Density of P. longaeva in the stands of this vegetation sampled averaged 59.7 (±62.0) m^2 ha^{-1} and 127.9 (±96.6) stems ha^{-1} respectively. Table 2 gives the individual plot data.

The following four association types are named provisionally on the basis of limited observations. These vegetation units are more closely allied to lower-subalpine and montane vegetation of the White Mountains on surrounding lands in the Ancient Bristlecone Pine Forest and Inyo National Forest, for which there is meager stand data upon which to base a classification.

Pinus longaeva-Cercocarpus intricatus association. Subalpine forests on dolomite below about 3100 m in the southern White Mountains are an admixture of P. longaeva stands with or without a large shrub understory dominated by Cercocarpus intricatus. Due to the limited nature of this reconnaissance survey and to the complexity of the vegetation mosaic below 3100 m, complete characterization of this type was not attempted and no stands were placed herein. The area mapped as this vegetation on Map 4 shows the general geographic distribution of this type on the Natural Area, although the actual vegetation on the ground is an admixture of this type and the P. longaeva association.

Pinus flexilis-Cercocarpus ledifolius association. Pinus flexilis codominates the tree canopy of the lower slopes in the Natural Area with P. longaeva on rocky sites. Here tree canopy coverage is often high, approaching ca. 50%, and P. longaeva assumes a more tapered growth-form. Cercocarpus ledifolius replaces C. intricatus in this vegetation, and hybrids are commonly encountered (Brayton and Mooney 1966).

Populus tremuloides association. Populus tremuloides forms dense clones on mesic sites in the lower reaches of the Natural Area, as along Poison Creek and South Fork Cottonwood Creek. The understory of this vegetation is dense, with high cover of numerous herbaceous species. Elymus cinereus, Agropyron trachycalum and Artemisia dracunculus are common associates.

Meadows. Meadow vegetation occurs on White Mountain Natural Area at the junction of Poison Creek with South Fork Cottonwood Creek, and on the rolling slopes of the southwest corner near Campito Meadow. The latter meadow is grazed moderately, and is dominated by Juncus balticus, Poa fendleriana, Muhlenbergia richardsonis and Carex douglasii. Meadows along the lower reaches of the Natural Area are perennially wet, whereas the upper meadow is dry by mid-summer. These lower meadows are vegetationally diverse, with a willow border of Salix lutea and S. pseudocordata. Artemisia cana ssp. bolanderi dominates the sites with higher calcium concentrations along with Carex praegracilis, Melica bulbosa and Muhlenbergia richardsonis. The meadows proper are dominated by Deschampsia caespitosa, Carex nebrascensis, C. scirpiformis, Scirpus pumilus and Sisyrinchium idahoense.

Rare Plants. The following sensitive plant species as listed by the California Native Plant Society (Powell 1974) occur on the White Mountain Natural Area:

Eriogonum gracilipes

Listed by the CNPS REVD code as 1- - - (blanks indicate lack of listing

information for a given code, cf. Powell 1974). This taxon is dominant on alpine dolomite substrates (cf. Table 1!). I would rate the taxon 1-1-1-3 using the CNPS code.

Astragalus kentrophyton danaus

Common on dolomite in the subalpine and alpine (cf. Table 1). CNPS listing 1-1-1-3.

Lomatium inyoense (L. foeniculaceum ssp. inyoense)

Common on dolomite in Pinus longaeva stands. Rated 2-1-1-2 by the CNPS. I would rate this taxon 1-1-1-3 on the basis of its very extensive distribution in the southern White Mountains.

Scirpus pumilus (S. rolandii)

This species was collected (#6568 DAV) from the calcareous meadows at the lower end of White Mountain Natural Area. The only previous record for California is from the Convict Creek basin in the Sierra Nevada. The species is listed as 1 - - - by the CNPS. I would rate this taxon as 1-1-1-2.

Carex scirpiformis Mkze.

The first record in California for this species was collected as part of this reconnaissance survey from the calcareous meadow at the lower end of the Natural Area (#6565 DAV). The specimens taken agree quite well with the circumscription of C. scirpiformis in Mackenzie (1931) and Heerman (1970), being aphyllopodic and lacking a terminal bract below the inflorescence. Carex scirpiformis is reduced to a synonym of C. pseudoscirpoidea by Cronquist et al. (1976). I would rate the species as 3-1-2-1 using the CNPS code.

Discussion and Recommendations.

A survey of the distribution of P. longaeva populations in the Inyo-White Mountains has not been attempted to date; to be sure, there are very extensive

forests of this species in this mountain axis. The P. longaeva populations located in the white Mountain Natural Area and in the Ancient Bristlecone Pine Forest are all stands located on dolomite, while there are extensive stands on non-calcareous rocks in the northern White Mountains and in the Inyo Mountains. The extensive amount of ecological research on P. longaeva has concentrated about the Natural Area and vicinity largely because of the substrate-oriented distribution patterns there, as well as the ease of access via road. While the studies centered about the dolomitic P. longaeva stands are valuable, they form only an incomplete picture of the ecology of this vegetation. The extensive stands of P. longaeva in the Inyo Mountains have beer visited only by plant collectors, and nothing is known about the ecology of this vegetation.

Recommendations:

1). Grazing impact occurs annually on both the upper and lower portions of the Natural Area. For the most part, it is minimal in extent, because of low herbaceous productivity. The meadows along the creeks at the lower boundary of the Natural Area are heavily grazed. Carex scirpiformis and Scirpus pumilus both occur in these meadows and are being impacted as a result. Grazing allotments adjacent to the Natural Area should be reviewed and/or eliminated so as to restrict this use.

2). Signing is mostly non-existent around the perimeter of the Natural Area. A visitor approaching via the upper reaches along the roadways may or may not have been contacted at the entrance station near Westgard Pass, since this facility is not operated during the entire season when the area is accessible. A visitor approaching up the canyon of Cottonwood Creek sees no notice of their entrance into the Natural Area. Suitable signing should be placed (in an unobtrusive way) to correct this situation.

3). Any consideration of establishment of additional Research Natural Areas to represent noncalcareous Pinus longaeva groves should only be made after an extensive botanical survey is conducted on the Inyo Mountains populations.

Plant Species List

The following plant list gives those species which were collected or observed on the White Mountain Natural Area during the course of this survey. Taxa not listed in Lloyd and Mitchell for the White Mts. are indicated by *.

Amaryllidaceae
- Allium bisceptrum

Apiaceae
- Angelica kingii
- Cymopterus cinerarius
- Lomatium inyoense

Apocynaceae
- Apocynum cannabinum

Aspidiaceae
- Cystopteris fragilis

Asteraceae
- Achillea lanulosa ssp. alpicola
- Agoseris glauca var. monticola
- Arnica chamissonis ssp. foliosa
- A. parryi var. sonnei
- Artemisia arbuscula
- *A. cana ssp. bolanderi
- A. dracunculus
- A. rothrockii
- A. tridentata ssp. *vaseyana
- Antennaria rosea
- Aster occidentalis
- Chrysothamnus nauseosus ssp. *albicaulis
- C. viscidiflorus
- Cirsium drummondii
- Erigeron clokeyi
- E. compositus
- E. lonchophyllus
- E. pygmaeus
- E. tener
- Eriophyllum lanatum var. ?
- Eupatorium occidentale
- Haplopappus acaulis
- H. apargioides
- H. macronema
- H. suffruticosus
- Hymenoxys cooperi
- Leucelene ericoides
- Machaeranthera shastensis var. montana
- *Nothocalais alpestris
- Raillardella argentea
- Senecio canus
- S. scorzonella

Asteraceae (concluded)
Senecio stygius
Solidago multiradiata
Taraxacum officinale
Townsendia condensata

Boraginaceae
Cryptantha circumscissa
C. confertiflora
C. flavoculata
C. jamesii
Hackelia patens

Brassicaceae
Arabis fernaldiana var. stylosa
A. hirsuta
A. inyoensis
A. lyallii var. nubigena
Draba breweri
D. oligosperma
D. stenoloba var. nana
Halimolobos virgata
Hutchinsia procumbens
Lesquerella kingii var. cordiformis
Streptanthus cordatus

Caryophyllaceae
Arenaria kingii ssp. compacta
Silene verecunda ssp. bernardina
Stellaria longipes

Crassulaceae
*Sedum lanceolatum

Cupressaceae
*Juniperus occidentalis ssp. australis

Cyperaceae
Carex abrupta
C. aurea
C. douglasii
C. eleocharis
C. filifolia
C. helleri
C. lanuginosa
C. nebrascensis
C. praegracilis
C. rossii
*C. scirpiformis
Eleocharis pauciflorus
*Scirpus pumilus

Ephedraceae
Ephedra viridis

Equisetaceae
  Equisetum laevigatum

Fabaceae
  Astragalus calycosus
  A. kentrophyta var. danaus
  A. lentiginosus var. ?
  Lupinus caespitosus
  L. caudatus
  L. meionanthus
  Oxytropis parryl
  Trifolium monanthum
  T. monoense

Gentianaceae
  Gentiana amarella

Hydrophyllaceae
  Phacelia hastata

Iridaceae
  Iris missouriensis
  Sisyrinchium idahoense

Juncaceae
  Juncus balticus
  J. mertensianus
  J. parryi

Lamiaceae
  Monardella odoratissima var. ?

Liliaceae
  Smilacina stellata

Linaceae
  Linum lewisii

Onagraceae
  Epilobium anagallidifolium
  Gayophytum diffusum ssp. parviflorum
  Oenothera avita

Orchidaceae
  Habenaria sparsiflora

Pinaceae
  Pinus flexilis
  P. longaeva

Polemoniaceae
  Ipomopsis congesta ssp. montana
  Leptodactylon pungens ssp. halliii
  L. p. ssp. pulchriflorum
  Linanthus nuttallii
  Phlox covillei

Polygonaceae
Eriogonum gracilipes
E. ovalifolium var. nivale
E. rosense
E. saxatile
E. umbellatum var. ?
Oxyria digyna
Rumex paucifolius ssp. gracilescens

Portulaceae
Calyptridium umbellatum var. caudiciferum
*Lewisia triphylla

Poaceae
Agropyron trachycaulum
Bromus richardsonii
B. tectorum
Calamagrostis purpurascens
Deschampsia caespitosa
Elymus cinereus
Festuca brachyphylla
Hordeum brachyantherum
Koeleria cristata
Leucopoa kingii
Melica bulbosa
M. stricta
Muhlenbergia richardsonis
M. filiformis
Oryzopsis hymenoides
Poa epilis
P. fendleriana
p. pratensis
P. rupicola
Sitanion hystrix
Stipa pinetorum
Trisetum spicatum

Primulaceae
Dodecatheon redolens

Pteridaceae
Cheilanthes parryi
Pellaea breweri

Ranunculaceae
Aquilegia formosa
Delphinium polycladon
Ranunculus cymbalaris var. saximontanus
Thalictrum sparsiflorum

Rubiaceae
Galium hypotrichium

Rosaceae
Cercocarpus intricatus
C. ledifolius

Rosaceae (continued)
- Chamaebatiaria millefolium
- Holodiscus microphyllus
- Ivesia lycopodioides ssp. scandularis
- Petrophytum caespitosum
- Potentilla breweri
- P. fruticosa
- Rosa woodsii var. ultramontana
- Sibbaldia procumbens

Salicaceae
- Populus tremuloides
- P. trichocarpa
- Salix lutea
- S. pseudocordata

Saxifragaceae
- Heuchera rubescens var. alpicola
- Ribes cereum

Scrophulariaceae
- Castilleja chromosa
- C. miniata
- C. nana
- Collinsia parviflora
- Mimulus guttatus
- M. primuloides
- M. suksdorfii
- Pedicularis attolens
- Penstemon heterodoxus
- P. oreocharis
- P. speciosus
- Veronica americana

Selaginellaceae
- Selaginella watsonii

Urticaceae
- Urtica holoserica

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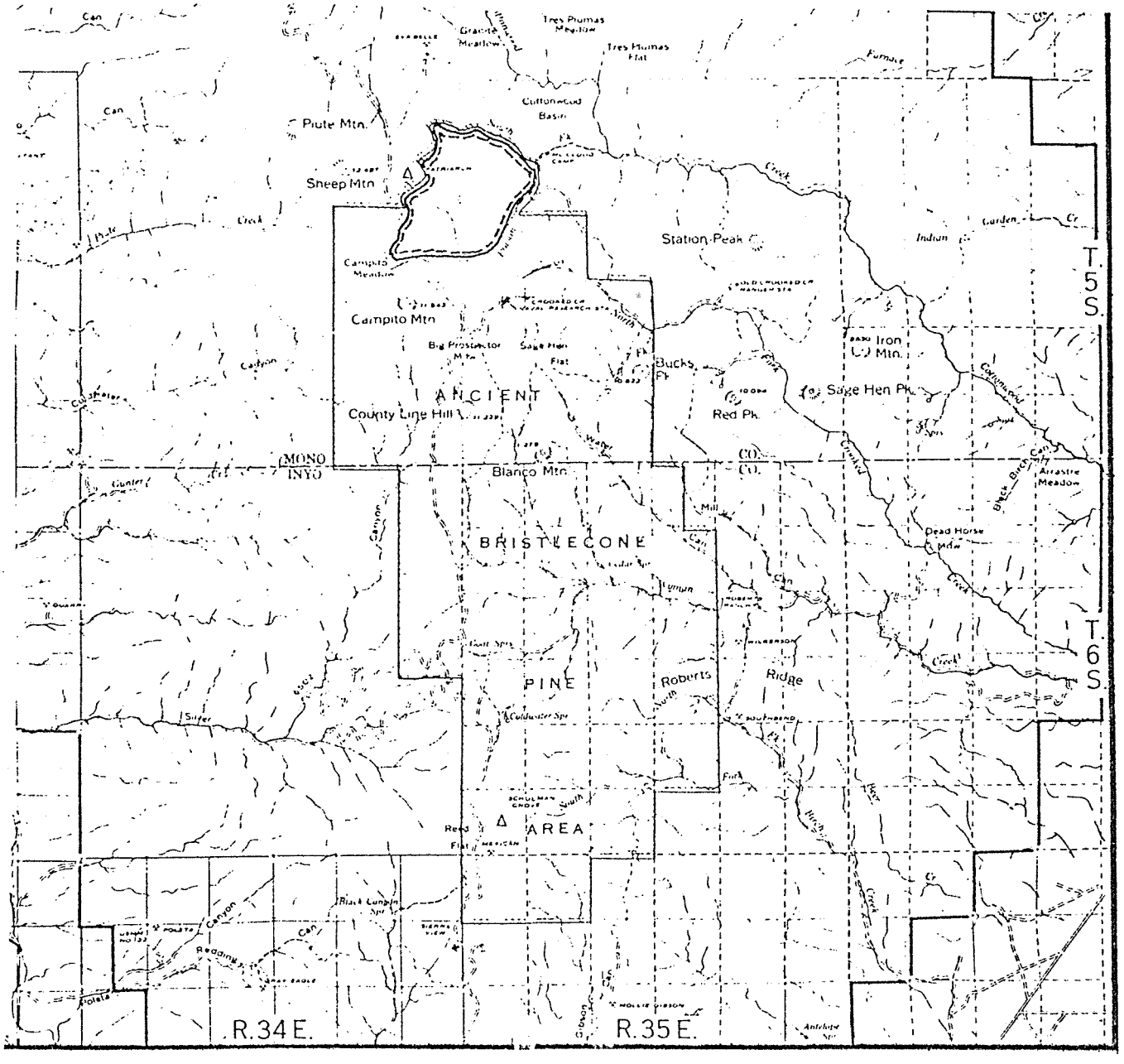
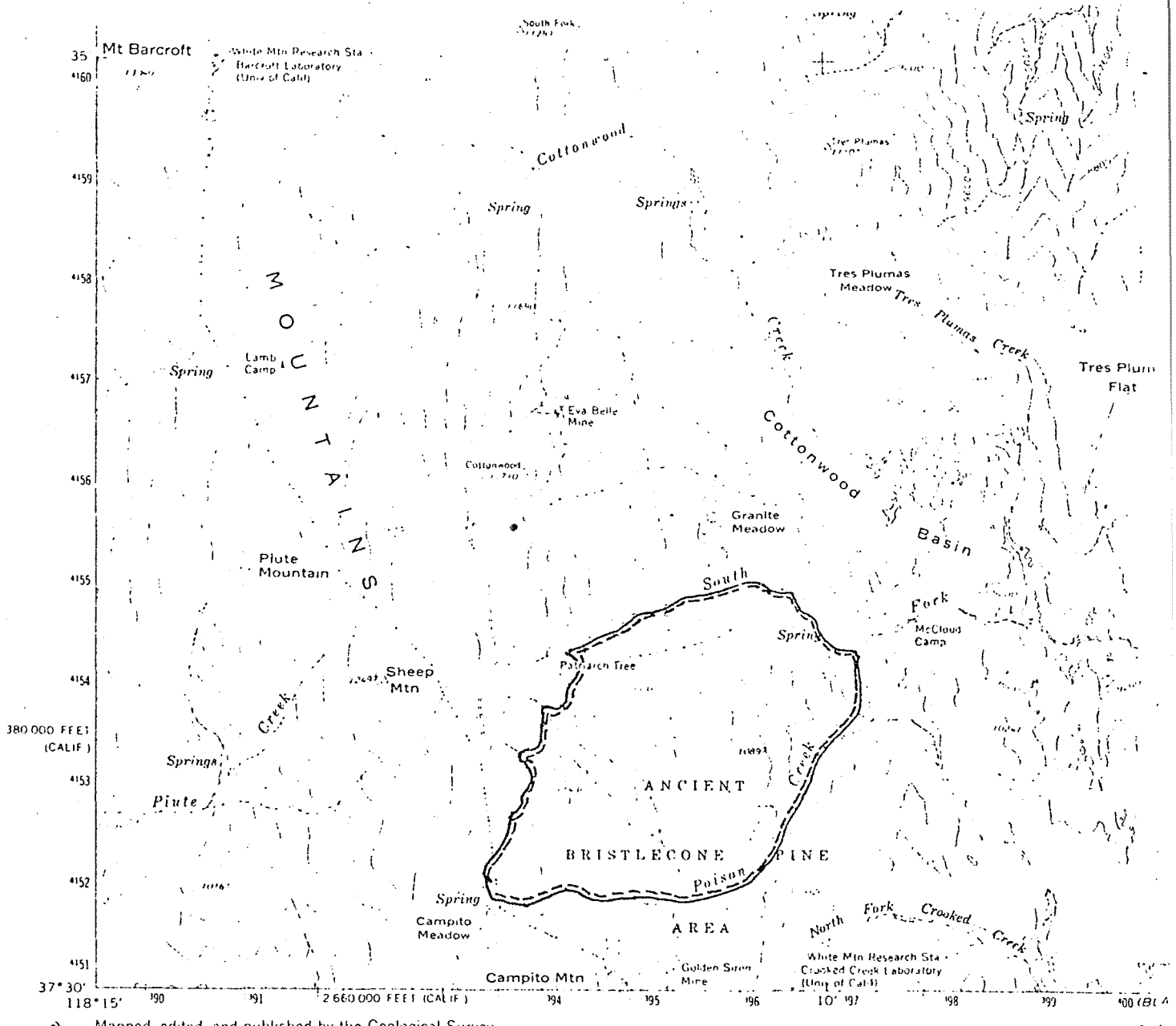
Map 1. Location of the White Mountain Natural area in relation to the adjacent Bristle Cone Pine Forest (to the south). Boundaries of the White Mountain Scientific Area are not shown on this map version, but begin about 2 km to the north of the Natural Area. Scale ca. 1:125000



Map 2. Portion of the U.S. Geological Survey Mt. Barcroft quadrangle showing the location of the White Mountain Natural Area. Scale ca. 1:62500



Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS and USCE

Topography by photogrammetric methods from aerial photographs taken 1954 Field checked 1962

Polyconic projection 1927 North American datum
10,000-foot grids based on California coordinate system, zone 3, and Nevada coordinate system, west zone
1000 meter Universal Transverse Mercator grid ticks zone 11, shown in blue

Where omitted, land lines have not been established or are not shown because of insufficient data

SCALE

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Map 3. Geologic map of the vicinity of White Mountain Natural Area. (Krauskopf 1971). Scale ca. 1:62500

Legend:

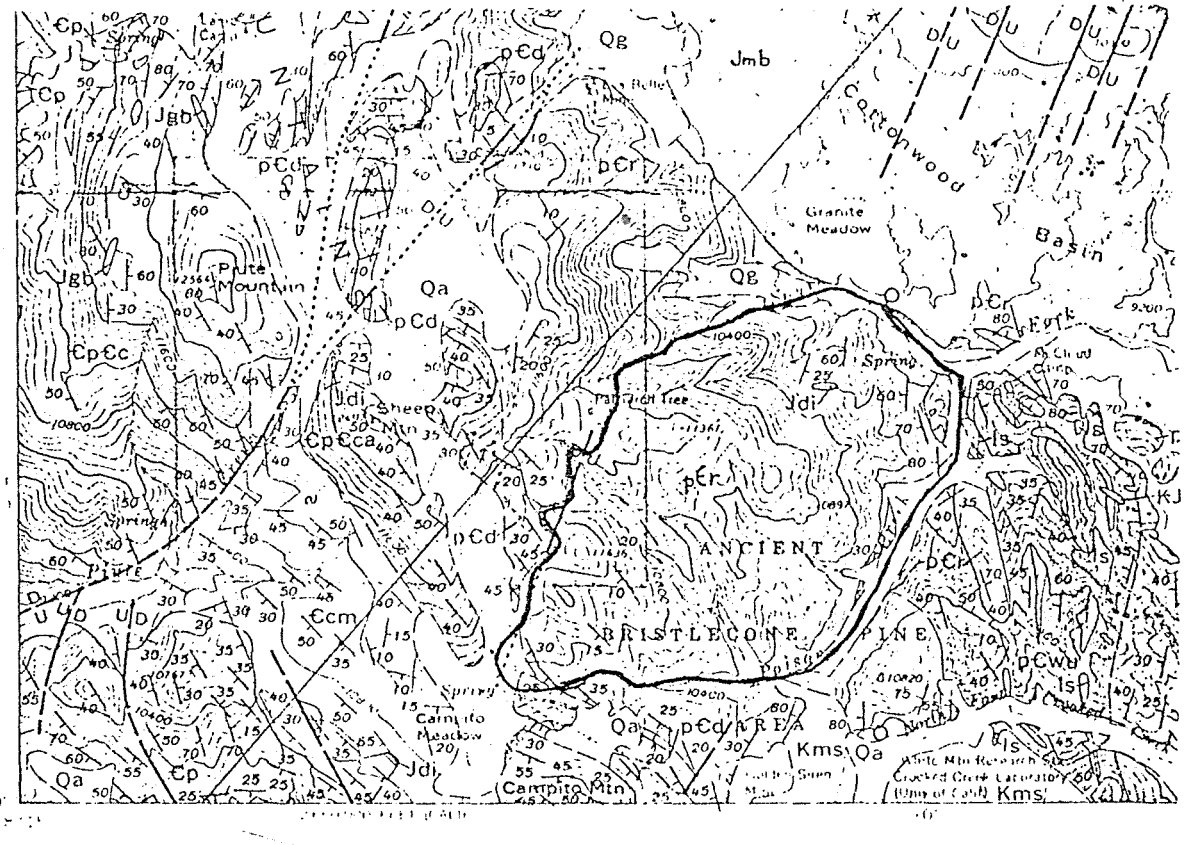
pEr Reed Dolomite

pEwu Wyman formation-limestones and hornfels

Jdi Jurassic age diorite Jmb Quartz monzonite

Qg Quaternary glacial till

Qa Quaternary alluvium

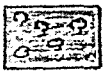


Map 4. Vegetation types of White Mt. RNA.

Scale ca. 1:12000

Phlox covillei-Eriogonum gracilipes

Artemisia rothrockii



Pinus flexilis-Cercocarpus ledifolius

meadows

Pinus longaeva

Pinus longaeva-Cercocarpus intr.

Populus tremuloides

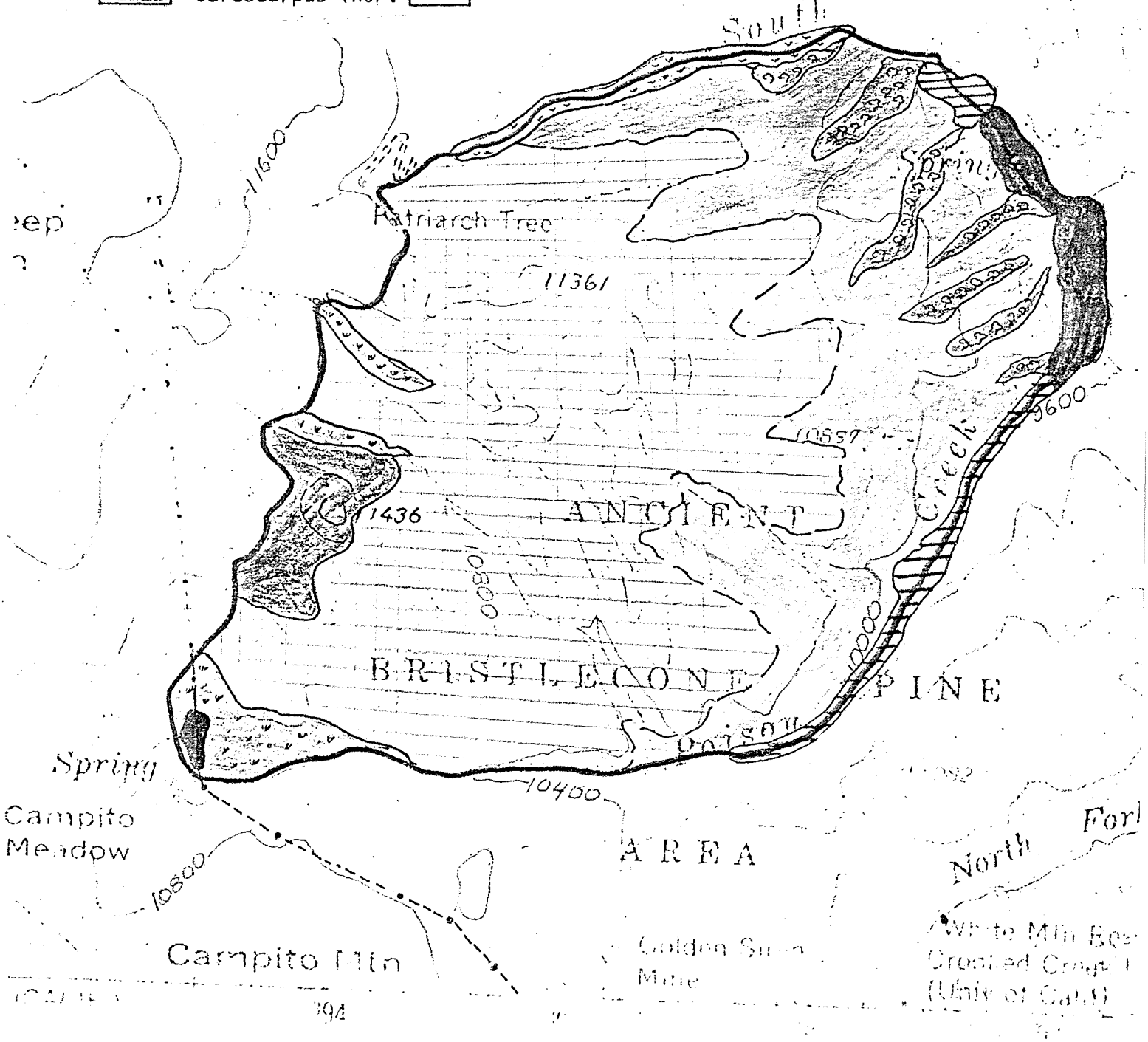


Figure 1. Idealized vegetation profile of calcareous areas in the southern White Mountains, east slope. Present timberline is now about 100 m below a Xerothermic extension of trees into the present alpine, as shown. Growth form of P. longaeva changes markedly along the altitudinal gradient. Shrub understory on lower slopes is mostly Cercocarpus spp.

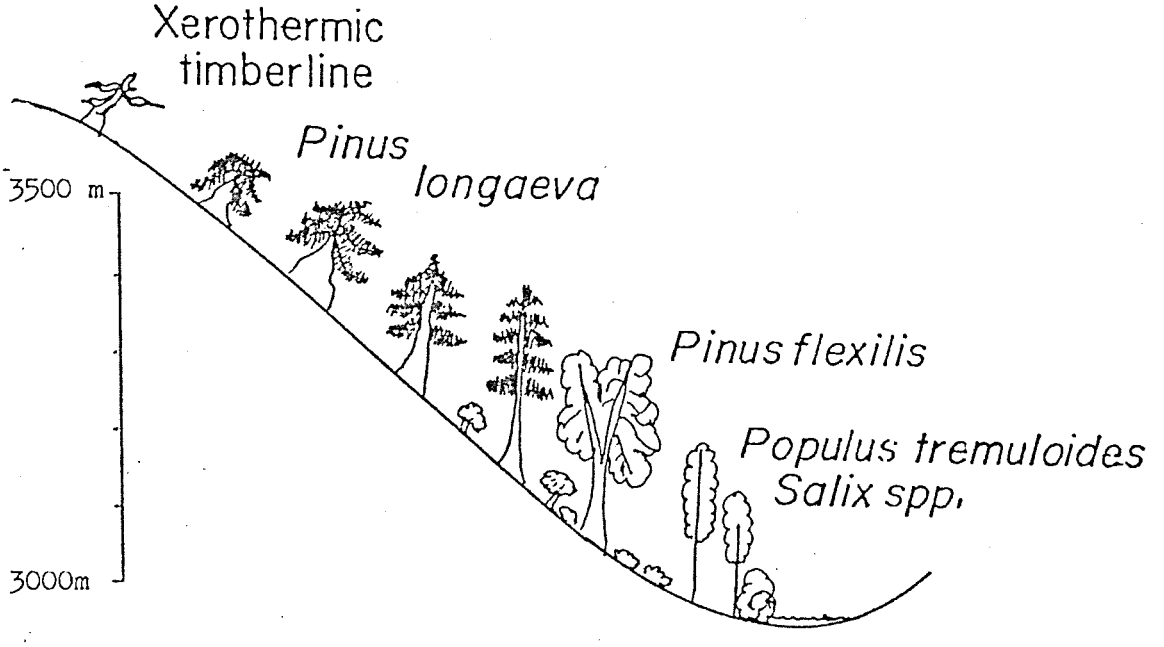
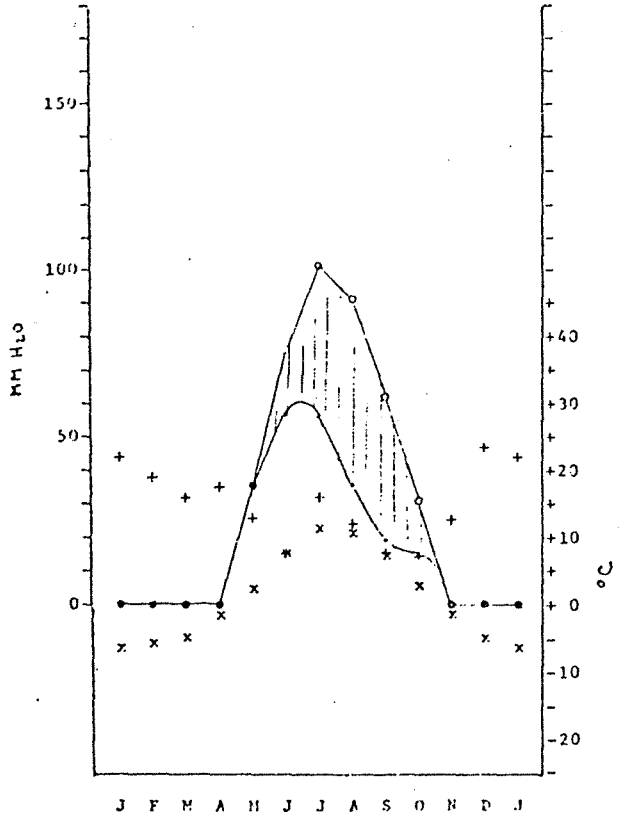


Figure 2. Climatic diagrams.

LOC: White Mountain # 1, Crooked Creek Lab. 10,150 ft = 3100 m. 1949-1973
LAT: 37.50 N
MAX SS: 100 mm

	J	F	M	A	M	J	J	A	S	O	N	D	YR
T	-6.7	-6.0	-5.1	-1.7	2.4	7.6	11.4	10.7	7.2	2.8	-1.7	-5.3	1.3
PE					36	77	102	91	62	31			399
P	44	38	32	35	26	15	32	24	15	14	25	47	347
SS	100	100	100	100	90	48	24	12	7	6	31	78	
AE					36	57	57	36	20	15			220
-						19	45	56	43	16			179
+	22	38	32	35									127



Legend: T = Temperature °C
PE = Potential Evapotranspiration
P = Precipitation
SS = Soil water at end of month
AE = Actual Evapotranspiration
- = monthly water deficit
+ = monthly water surplus

*—o = PE
•—• = AE
+—+ = P
x—x = T
|||| = period where plant growth is assumed to be limited by water

Figure 2 cont.

LOC: White Mountain #2, Barcroft Lab 1973-1953
LAT: 37.50 N
MAX SS: 100 mm

	J	F	M	A	M	J	J	A	S	O	N	D	YR
T	-9.1	-9.4	-9.1	-6.7	-2.4	3.0	7.4	6.9	3.8	-.4	-5.0	-8.2	-2.4
PE						53	88	80	51				273
P	61	41	48	47	55	25	36	30	20	30	35	66	496
SS	100	100	100	100	100	75	44	26	19	50	85	100	
AE						50	67	48	27				192
-						3	21	33	24				81
+	61	41	48	47	55							53	304

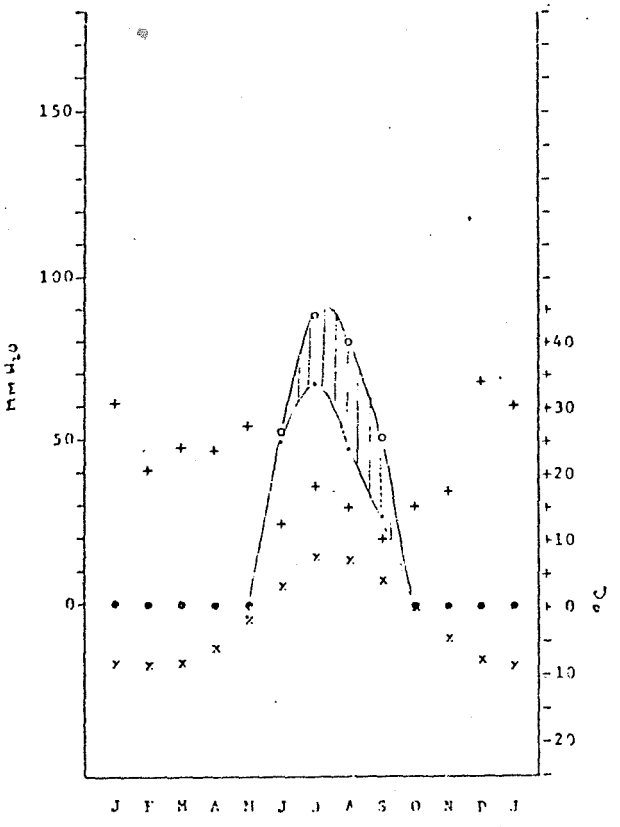


Table 1. Vegetation association table for the alpine-subalpine zone of the Southern White Mountains, California.

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Car
Des
Dra
Jur

Tri
Car
Eri
Lew
Rum

Art
Hap
Eri
Ast
Ast
Hym
Sit
Lin
Dra
Poa
Eri
Lep

Chr
Lom
Sti
Lup
Ago
Cry
Ipor

Pin
Hap
Lin
Cry
Care
Lesq

Pens
Haca
Oryz

Table 2. Summary data for the Pinus longaeva stands sampled on White Mountain Natural Area.

BASAL AREA PROGRAM
STAND No.= 663 White Mountain Natural Area BC-5
PLOT RADIUS= 15.000
PLOT AREA = 706.85meters

TAXON	BA (m^2/ha)	REL. DOM.	DENS. (#/ha)	REL. DENS.	IMP. VAL.	$\bar{X}$ DBH
Pinus longaeva	97.801	100.00	183.91	100.0	200.0	72.2
TOTALS	97.801		183.91			

BASAL AREA PROGRAM
STAND No.= 662 White Mountain Natural Area BC-6
PLOT RADIUS= 15.000
PLOT AREA = 706.85meters

TAXON	BA (m^2/ha)	REL. DOM.	DENS. (#/ha)	REL. DENS.	IMP. VAL.	$\bar{X}$ DBH
Pinus longaeva	18.374	100.00	127.32	100.0	200.0	29.6
TOTALS	18.374		127.32			

Table 2 cont.

BASAL AREA PROGRAM
STAND No.= 668 White Mountain Natural Area BC-0
PLOT RADIUS= 15.000
PLOT AREA = 706.85meters

TAXON	BA m^2/ha)	REL. DOM.	DENS. (#/ha)	REL. DENS.	IMP. VAL.	$\bar{X}$ DBH
Pinus longaeva	34.356	100.00	84.88	100.0	200.0	68.7
TOTALS	34.356		84.88			

BASAL AREA PROGRAM
STAND No.= 667 White Mountain Natural Area BC-1
PLOT RADIUS= 15.000
PLOT AREA = 706.85meters

TAXON	BA m^2/ha)	REL. DOM.	DENS. (#/ha)	REL. DENS.	IMP. VAL.	$\bar{X}$ DBH
Pinus longaeva	13.895	100.00	17.68	100.0	200.0	97.4
TOTALS	13.895		17.68			

BASAL AREA PROGRAM
STAND No.= 666 White Mountain Natural Area BC-2
PLOT RADIUS= 15.000
PLOT AREA = 706.85meters

TAXON	BA m^2/ha)	REL. DOM.	DENS. (#/ha)	REL. DENS.	IMP. VAL.	X DBH
Pinus longaeva	73.788	100.00	113.17	100.0	200.0	38.3
TOTALS	73.788		113.17			

BASAL AREA PROGRAM
STAND No.= 665 White Mountain Natural Area BC-3
PLOT RADIUS= 15.000
PLOT AREA = 706.85meters

TAXON	BA m^2/ha)	REL. DOM.	DENS. (#/ha)	REL. DENS.	IMP. VAL.	X DBH
Pinus longaeva	177.133	100.00	311.23	100.0	200.0	80.7
TOTALS	177.133		311.23			

BASAL AREA PROGRAM
STAND No.= 664 White Mountain Natural Area BC-4
PLOT RADIUS= 15.000
PLOT AREA = 706.85meters

TAXON	BA m^2/ha)	REL. DOM.	DENS. (#/ha)	REL. DENS.	IMP. VAL.	X DBH
Pinus longaeva	3.153	100.00	56.58	100.0	200.0	26.6
TOTALS	3.153		56.58			

Photo 1. Lower reaches of White Mountain Natural Area at junction of South Fork Cottonwood Creek with Poison Creek. Pinus longaeva-Cercocarpus intricatus vegetation is seen on the slopes in the background. Pinus flexilis-Cercocarpus ledifolius and Artemisia tridentata ssp. vaseyana vegetation is seen in the foreground slopes. Small meadow in foreground is bordered by Artemisia cana ssp. bolanderi and Salix pseudocordata.

Photo 2. View toward Sheep Mt. from along South Fork Cottonwood Creek at lower edge of Natural Area. Slope at left is Pinus longaeva-Cercocarpus intricatus dominated. Meadow here is bordered by Artemisia cana ssp. bolanderi, and is the locality for Carex scirpiformis and Scirpus pumilus.

Photo 3. Dry gully of the South Fork of Cottonwood Creek on northern boundary of White Mountain Natural Area. Extensive piles of dead wood is Pinus longaeva brought down by frequent avalanches. Artemisia rothrockii dominates this site.

Photo 4. Open Pinus longaeva subalpine woodland at the upper end of White Mountain Natural Area,